

The



*Technology Enhanced Learning
in Research-led Institutions*

Project

CASE STUDY

Bioinformatics on the Web

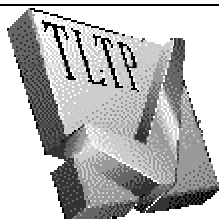
Evaluation from implementation in courses

The TELRI Project

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CASE STUDY

Bioinformatics on the Web

Title Bioinformatics on the Web	
Department	Biological Sciences
Institution	University of Warwick
Description of the course A new course on Bioinformatics integrating a problem-solving approach with critical discussion of appropriate approaches and choice of techniques. The focus of the course is on solving a real research problem in the area of genomics. Bioinformatics is a new area, comprising the analysis of biological sequence information, recovery of evolutionary patterns, prediction of gene function, biological data mining (not in the course) and "silicon-based biology". The amount of information in the bioinformatics databases is vast so we need sophisticated tools to deal with it. The web site provides suitable links to database and information resources at remote sites across the world. Students draw on these to find appropriate tools for their analyses. The course consists of seven modules and is driven by problem-solving exercises embedded in each of the modules. The students are given a DNA sequence and are expected to do a series of analyses on it. The course modules are designed to help students to deconstruct this complex task into a set of relatively simple exercises. In doing so, the course has two important aims; one is just to be aware of the techniques in bioinformatics and to teach students how to apply them and the other is that students gain understanding in the underlying theory.	Course details <ul style="list-style-type: none"> • Second year course • Optional • 5 week duration (in 2nd half of term 2) • 25 students <p>Each module incorporates a brief series of exercises, based entirely on publicly available web sites and programs. These exercises illustrate particular concepts and techniques associated with the module and familiarity with these techniques and concepts will be tested throughout the course.</p> <p>The department is keen to develop bioinformatics as a core course, given the increasing demand in industry for capabilities in this field.</p>

<p>Details of the TELRI intervention and how it aimed to enhance the learning and course activities</p> <p>This web-based course is designed to encourage problem solving and to develop research skills. The theory and practices move on quickly so this approach enables the materials and methods to keep pace with current trends.</p> <p>The course makes extensive use of web-based tools, some of which are ephemeral – this means the course can alter on the fly and means students can apply what they've learned anywhere in the world through the use of the Internet.</p> <p>Students are provided with a web publishing area where they can present their findings and discuss with peers their choices. This critical analysis of approaches proposed or taken is crucial to the development of understanding of the techniques being explored. A large proportion of the students' final report will draw conclusions from these discussions.</p>	<p>Other teaching methods used to support activity</p> <ul style="list-style-type: none"> • An introductory lecture • 2 clinics per week to discuss problems <p>Other technologies used to support activity</p> <p>The course is entirely web-based with databases, analysis software, discussion and publishing facilities incorporated.</p> <p>In keeping with the practical motivation for the subject, we felt it was more appropriate to learn the skills this way and understand why they are appropriate. The tools and databases we teach are the ones currently used in research, not watered down versions. Thus, the skills students acquire are immediately applicable to real world problems in sequence analysis.</p>
<p>How the course was previously run (if applicable)</p> <p>This is the first course on Bioinformatics.</p>	<p>Problems with previous teaching methods</p> <p>Teaching bioinformatics in the conventional way would be dull as it is a highly practical subject, best learned hands on.</p>
<p>Intended capabilities to be developed</p> <p>The need to develop knowledge and techniques is driven by the students' need to work through the problem. The final assessed output is a research report, which emphasises the students' reasoning and justification in deciding the appropriate procedures and resources to utilise. Furthermore, students' are expected to develop the ability to think critically about the results they are obtaining and to discuss this in their report.</p> <p>Through this approach, students also gain understanding of (i) how different programs require data to be inputted in different formats, and (ii) the importance of this in terms of obtaining a sensible answer to data analysis. These are prerequisites to performing accurate research.</p>	<p>Methods of assessment</p> <p>The course is assessed by a written submission (60%) and a practical test (40%). The written research report is expected to demonstrate the students' understanding of the principles that underlay their decisions in their problem analysis, for example, of genomic data. Informal assessment also occurs at stages throughout the course to ensure students are on the right track as they analyse the given data.</p> <p>For the second run, the tutor will increase the proportion of marks assigned to the written research report to 70%, with only 30% for the practical exercises.</p>

<p>Problems in setting up the course or technology</p> <p>Since the course was constructed from scratch, it took the tutors a considerable amount of time to write the module materials. However, this material can easily be updated for subsequent years, so was time well-spent.</p> <p>The course started being developed from two perspectives, one technique orientated and the other theory orientated, reflecting the research focus of each department. This caused some problems in designing the way students worked through the problem and the modules and resources they were expected to use.</p>	<p>How these were solved</p> <p>Initially, the course was being developed in collaboration with Zoology department Oxford University. At the planning stage, therefore, it was envisaged that producing the materials jointly produced would reduce the work load on the individual tutors in each department.</p> <p>However, the tutor at Oxford obtained a Royal Society University Research Fellowship, which meant that he could relinquish all teaching duties and, disappointingly, the Oxford course was postponed.</p> <p>Awareness and use of bioinformatics techniques, together with limited consideration of theory, constitutes the bulk of the course and has been referred to in the course as Level 1. More detailed theoretical considerations are dealt with in Level 2.</p>
<p>Extent of development of intended outcomes</p> <p>TELRI evaluation</p> <p>The problem of students leaving the reflection of their approaches and findings until the final assignment was due is fairly predictable.</p> <p>The original plan for the course design moved the focus of the students' activities to the web publishing area. Due to restraints on time for the pilot course, this approach was planned for the second run of the course and is outlined below.</p> <p>The course incorporated an early assignment where the students must submit a "plan of action" for tackling the research problem. This would be published directly to the web and after the deadline, students could view the approaches of others, reflect, discuss and review their own plans prior to embarking on the analysis. Likewise, once the students worked through the problem and obtained their results, their next assignment would be to publish these to the web alongside a critique of the findings and methods and resources used to obtain them.</p> <p>The initial approach was designed with two main objectives in mind. Firstly, it would encourage students to think about and discuss</p>	<p>Academic tutor evaluation</p> <p>The course tutor remarked that the majority of students produced high quality work. There was the usual range, with some students demonstrating highly developed analytical and evaluative skills, while others' were more limited.</p> <p>While the tutor intended that the final report be submitted in the form of a research paper, he found that some students had obviously not looked to the journals as a guide to appropriate format and quality. However, generally, the quality of presentation and structure of the written work was high with good evidence of logical structure to the students' approaches and arguments.</p> <p>The main disappointment noted by the tutor was that students had tended to attend only the initial clinic sessions. This resulted in a deluge of email enquiries prior to the deadline for the final report. The tutor's aim was that students kept a form of reflective journal whilst working through the problem and that this formed the basis of the research report. This appeared not to happen and students fell into the usual trap of leaving the write up until the assignment deadline.</p>

<p>critically their approaches and the results they obtained during rather than after the analysis work. Secondly, it would create a feeling of a research community amongst the students, rather than treating the activity as an individual one. This is likely to solve the criticism by the students of the lack of guidance on the problem-solving exercises and feedback on the final report.</p>	<p>Students evaluation</p> <p>Post-course questionnaires revealed that overall, the students enjoyed the course and commented on the novel learning and teaching approach. There was some confusion as to what was expected (<i>see Further developments section below for some solutions.</i>)</p> <p>In general they liked the challenges presented and felt a high level of motivation to work through the problem. However, they did feel that the emphasis on the final assignment was too heavy - <i>probably since they left it all to the end!</i></p> <p>The students commented that they appreciated the use of real research techniques and genuine databases and resources used in industry and research practice.</p>
<p>Unintended benefits or costs</p> <p>TELRI evaluation</p> <p>The tutor noted that updating the materials would need to be an annual event, since bioinformatics is a rapidly evolving field. This presents a slight problem since the web site was initially designed and produced by the TELRI team. The tutor contributes the "content" as separate HTML files and uploaded onto the TELRI directory on the University central server. This involves transferring files to and from server for editing. While this is not a time-consuming task, it is rather tedious compared to other web sites the tutor handles using FrontPage where editing, saving and publishing is fairly seamless. Of course, originally, the web site was planned to support the two collaborating institutions - Warwick and Oxford - and thus involved two (actually three) tutors. A simple HTML file transfer process was deemed the best way for multiple and remote content providers.</p> <p>While pretty straightforward to solve, the above awkwardness is not uncommon. At the start of the course design, it is important to consider not only <i>who</i> will update the site, but also <i>how</i> they prefer to do so. And hope that doesn't change!</p>	<p>Academic tutor evaluation</p> <p>Early (rather than later) development of commercial versions of the course. This was particularly pleasing to the tutor, since it indicated that the pilot was already a success, and to the department since it can generate an earned income from its teaching activities making updating less costly.</p> <p>The increased use of departmental IT facilities as a result of the course was also welcomed.</p> <p>The high proportion of contact time assigned to the course meant that some clinics were poorly attended, most likely because they were superfluous. Switching to the web publishing approach for early submission of the research plan and for discussion of the students' results would make this even more unnecessary and thus reduce staff costs in terms of delivery time.</p> <p>Students evaluation</p> <p>24 out of 25 post-course questionnaires were received from students who took this option.</p> <p>A number of students commented that they had developed important transferable IT skills as a result of taking the course. The ability to work with computers and handles large amounts of information and data is highly</p>

	<p>valued in industry, particularly in the field of bioinformatics.</p> <p>The positive response to the course is more than likely understated in the student comments, since they have never experienced a lecture-based equivalent of this topic. Shifting to a web-based course can inadvertently lead to a reduction in student contact and learning support and more often than not, students complain bitterly about such courses, feeling "dumped". The students comments included that they found the course interesting, enjoyable, challenging, appropriate to their degree course. One said they welcomed the "novel approach that made a change from normal lectures" with only polite comments that they would have liked "more guidance" on the report and analysis of results. They like the continuous nature of the assessment, that they could work at their own pace and that there were "no exams".</p>
<p>Cost-effectiveness analysis</p> <p>Overall, the course was costly to produce, but the benefits are enormous both in short-term gains and certainly in the longer term. Both the quality student learning and the level of learning were considered to be high.</p> <p>Implementation of the course has involved the largest proportion of the project's time of all courses supported. Having said that, however, it was one of our earliest course developments and as such the discussions about course design formed the basis for much of our later thinking on research-based learning and subsequent TELRI framework.</p> <p>In terms of tutor time, a considerable number of preparation hours were involved. The course development and implementation was also a learning experience for the tutors, but thought to be a valuable investment for the department as a whole. Owing to the high demand for bioinformatics skills and understanding, the department placed the course development on a fairly high priority. The cost in staff preparation time is therefore thought to be extremely beneficial in the long run.</p> <p>The development of a sister course for industry as a commercial venture (see below) is considered a great reward for all efforts.</p>	<p>To what extent can the course design approach support higher student numbers?</p> <p>Following the pilot course, the department intended to offer bioinformatics as a core course, thus involving at least 160 students. It was therefore always assumed that the course design should include the ability to support high numbers of students.</p> <p>In the second run of the course, many of the changes suggested in the evaluation sections here will be incorporated. It is envisaged that the approach will increase the support and guidance for learning that the students gain from sharing and discussing each other's approaches and findings. The assessed research report can be brief, providing a reflective writing critique alongside documentation of approaches and results.</p> <p>Alternatively, the tutor may wish to consider a peer assessment approach, similar to that used in the <i>TELRI case study in Computer Science</i>.</p> <p>The use of the approaches for a commercial course aimed at industry professional development supports its applicability for a wide range of student backgrounds and student numbers.</p>

Further developments planned for this or other courses

The course ran last year with 25 students and will run again this year. The second run of the course will incorporate at least the early assignment (*see section on Extent of development of intended outcomes TELRI evaluation*). Furthermore, a new section - Getting started & Getting finished - is being added to provide clearer guidance to students in both the research planning and the results critique. Examples of high quality work from previous students on the course will be available as well as easy links to journals in the field (where available online).

Another tutor in the department is also developing a short residential course for industry, based on the undergraduate version and have several people registered already.

Bioinformatics web site

